ABSTRACT

Background: Acid etching of Glass Ionomer liner to increase bond strength between Glass Ionomer cement and composite resin. Aims & Objectives: To compare the tensile bond strength of Glass Ionomer cement to composite resin with and without acid etching the cement. Materials and Method: Ten pairs of metal cylinders (mould) were prepared for this study. Four groups based on hybrid and micro filled type of composite resin in 10 pairs each. In each type, 10 Glass Ionomer specimens were treated with acid etching and 10 were not treated. Results: The results showed no significant differences between any of four groups, showing that application of 37% phosphoric acid did not result in significant bond strength between Glass Ionomer cement and composite resin. Conclusion: Both the types of composite resin did not show any significant difference in bond strength to Glass Ionomer cement, whether etched or unetched.

Key Words: Glass Ionomer; Composite Resin; Bond Strength

Introduction

Previously, composite resins were mainly limited to stress bearing areas such as class III, class V (with sufficient surrounding etchable enamel) and at the best, small class I restoration, which do not come under severe masticatory stress. But, with time people started to demand for tooth colour restoration in posterior teeth also. So, posterior composite resins started to flood the market from early eighties. They overcame the wear resistance to some extent, but bonding to dentin/cementum and eliminating micro leakage at dentinal/ cemental resin interface remains a problem till date (both at class I and class V lesions). There are several dentin bonding agents ranging from first to seventh generations giving conflicting reports, but hundred percent efficacy still remains a dream. Mclean in 1985 proposed a solution to this problem by using Glass Ionomer cement as liner under composite resins.1 Glass Ionomer bonds chemically to dentin/cementum, but composite resins have got inadequate bond strength to dentin. So, the bond strength between Glass Ionomer and composite resin is quite important for clinical efficacy of this “Sandwich”, to counteract the strength generated by polymerization shrinkage and thermal changes of composite resins in oral cavity.2

Initially, Mclean advocated acid etching of Glass Ionomer liner to increase bond strength between Glass Ionomer cement and composite resin.3 But, following the report of smith4 about possible deterioration of Glass Ionomer cement following acid etching, Sheth5 reported a non-significant difference in tensile bond strength between etched and unetched Glass Ionomer cement to composite resin, scientists began to seriously consider unetched Glass Ionomer as liner under composite resin. There have been a number of studies in this field, but this matter has not been equivocally solved. The purpose of this study was to compare the tensile bond strength of Glass Ionomer cement to composite resin with and without etching the cement.

Materials and Methods

A laboratory study was carried out to compare the tensile bond strength of glass ionomer cement to composite resin with and without etching of glass ionomer cement. The materials used in present study were tabulated on Table 1.

Ten pairs of metal cylinders (mould) were prepared for this study, each being 6mm in length and having a hole in center of 3mm diameter. One cylinder of a pair had one end closed while other had both ends open. Both had metal hooks attached to them. Glass Ionomer cement was hand packed in to one cylinder having one end closed, as far as possible. The cement was allowed to set against a glass slab applied over the mould for 7 minutes. Then the glass slab was removed as much as possible. Then 37% phosphoric acid was applied on to the Glass Ionomer surface for 30 seconds followed by air drying for 30 seconds. Bonding agent was then applied and then air dried light was shown. Then the other half of mould was aligned with this part and fixed with sticking plaster (leucoplast). Then composite resin is packed in to mould by application of the three increments of 2mm each and each increment was cured by activation with visible light curing unit for 40 seconds. Then the moulds were kept in distilled water for 24 hours. Then they were taken out and leucoplast removed, and positioned in universal testing machine (Instron Corporation) and they were slowly pulled apart at a crosshead speed.
of 0.5cm/minute to an accuracy of 1 gm. This procedure was repeated in 4 groups using hybrid and micro filled type of composite resin in 10 pairs each. In each types, 10 Glass Ionomer specimens were treated with acid as in table 2.

<table>
<thead>
<tr>
<th>Group I</th>
<th>Gl Cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid Etching</td>
<td></td>
</tr>
<tr>
<td>Dentin Bonding Agent</td>
<td></td>
</tr>
<tr>
<td>Hybrid Type of composite Resin</td>
<td></td>
</tr>
<tr>
<td>Group II</td>
<td>Glass Ionomer Cement</td>
</tr>
<tr>
<td>Dentin Bonding Agent</td>
<td></td>
</tr>
<tr>
<td>Hybrid Type Of Composite Resin</td>
<td></td>
</tr>
<tr>
<td>Group III</td>
<td>Glass Ionomer Cement</td>
</tr>
<tr>
<td>Acid Etching</td>
<td></td>
</tr>
<tr>
<td>Dentin Bonding Agent</td>
<td></td>
</tr>
<tr>
<td>Microfilled Type of Composite Resin</td>
<td></td>
</tr>
<tr>
<td>Group IV</td>
<td>Glass Ionomer Cement</td>
</tr>
<tr>
<td>Dentin Bonding Agent</td>
<td></td>
</tr>
<tr>
<td>Microfilled Type of Composite Agent</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Group distribution in relation to acid treatment

Results
A laboratory study was carried out comparing the adhesive bond strength of Glass Ionomer cement to composite resin with and without application of 37% phosphoric acid to Glass Ionomer cement. The effect of two different types of composite resin, microfilled and hybrid, on the bond strength was also evaluated. The experiment was conducted in four phases with four different groups each containing 10 paired specimen (table 3).

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of pairs</th>
<th>Mean load (Kgs)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>10</td>
<td>4.3</td>
<td>1.020892</td>
</tr>
<tr>
<td>II</td>
<td>10</td>
<td>4.095</td>
<td>1.029954</td>
</tr>
<tr>
<td>III</td>
<td>10</td>
<td>3.617</td>
<td>1.065520</td>
</tr>
<tr>
<td>IV</td>
<td>10</td>
<td>3.81</td>
<td>0.414192</td>
</tr>
</tbody>
</table>

Table 5. Mean, SD of each Group

Group I : 15.20 kg/cm²
Group II : 14.47 kg/cm²
Group III : 12.53 kg/cm²
Group IV : 13.47 kg/cm²

Table 6. Mean kg/cm² of 4 groups

Discussion
Bonding or micromechanical attachment of composite resin to enamel is one of most reliable and widely used method which significantly minimizes marginal percolation, which is possible by application of 30-50% phosphoric acid over enamel surface popularly known as acid etching, but acid pretreatment of dentin and/or cementum is still a very debatable subject. Brannstorm and Gwinett had shown that acid etching of dentin caused undesirable pulpal response. Fujitani reported reduction of number of odontoblasts by direct etching of dentinal walls. It is argued that acid application in some dentin bonding does not cause any undesirable pulpal responses. Pashley in a well-organized review recommended that acid etching of dentin caused undesirable pulpal response. He advised lowering of concentration of acids to approximately 1%, minimizing etching time to prevent denaturation of collagen etc. These recommendations still cannot be followed.
The “dentin-bonding” systems have definitely reduced the degree of marginal gap formation at composite-dentin interface, but they do not obliterate it. One of the main disadvantages of dentin bonding agents are lack of cariostatic action. Mclean suggested the use of Glass Ionomer (glass polyalkenoate) cements, as a base or liner under composite resin. It has been shown that Glass Ionomer cements release fluoride which is responsible for its anticariogenic action.9 Glass Ionomer cements can effectively adhere to/bond to enamel and dentin, and are biocompatible. Mclean also recommended application of 37% phosphoric acid over Glass Ionomer base for 60 seconds to increase the bond strength between Glass Ionomer and composite resins.9

The effect of phosphoric acid over Glass Ionomer cement has been examined by Smith.10 He reported dissolving of gel matrix within initial 5 seconds, leaving clusters of glass particles covered with gel matrix. By 10 seconds, considerable surface porosities appeared which increased to voidlike space in 15 seconds. It is presumed that composite resin or intervening bonding agent will form tags inside these parts. Smith strongly advised against etching of Glass Ionomer cements for more than 30 seconds.

Following the initial advent of this “Sandwich technique” by Mclean, a number of scientists have confirmed increased bond strength(tensile) between Glass Ionomer cement and composite resin following application of phosphoric acid over Glass Ionomer cement when compared with bond strength between unetched Glass Ionomer and composite resin. But slowly some important questions started to arise. It has been shown that bond strength of etched Glass Ionomer to composite resin is greater than bond strength of Glass Ionomer to dentin. So the polymerization contraction of composite resin may pull away Glass Ionomer bases from dentin wall, there by disrupting adaptation of Glass Ionomer. Fusyama and Dynada reported that etched Glass Ionomer cement under composite resin showed more microleakage when compared with unetched ones.11 It is also said that adhesion between resin and base materials reduce free surface of resin mass and without other materials to compensate for volumetric shrinkage induced by polymerization, contraction stresses are generated at tooth-restoration interfaces. Resultant marginal enamel fractures can occur immediately after finishing of restorations.

Walker reported significant drop in pH underneath 0.5mm cement layer when acid is applied over it.12 The process of acid etching a non-uniform layer of Glass Ionomer cement on an uneven cavity floor may cause some acid to dissolve cement matrix almost completely in very thin areas which may result in expansion and widening of dentinal tubules. Dentinal areas inadvertently left uncovered by cement may also be affected by transient acid wash.11

So, the emphasis turned to “Sandwiches” without phosphoric acid, with Sheth5 and Welbury13 reporting non-significant differences between bond strength of etched and unetched Glass Ionomer cement to composite resin. They argued that micro roughness of unfinished Glass Ionomer may be sufficient for clinical efficacy of bond. A very strong bond may pull away Glass Ionomer from underlying dentinal surface. In the present study, there were also no significant differences found in bond strength between etched and unetched Glass Ionomer cements to composite resins, both microfilled and hybrid, mean bond strength being 15.20 kg/cm², 14.47 kg/cm², 12.53 kg/cm² and 13.47 kg/cm² in Group I, II, III and IV respectively which was result to be found by Sheth.5

Hinoura reported a wide ranging bond strength value for unetched Glass Ionomer to composite resin using two different Glass Ionomer and eleven different composite resins, bond strength values ranging from 3.3 to 65.2 kg/cm².14 It is hard to explain why majority of previous scientists and researchers reported higher bond strength of etched Glass Ionomer cement to composite resin. The lowering of etching time from 60 to 30 seconds, use of bonding agent and experimental conditions under which the experiments have been done significantly differ from most continental experiments.

The time required for Glass Ionomer cement to mature following which acid application should be done is again controversial. Mount recommended 6-8 minutes time from start of mixing and lining and reinforced restorative type and 20 minutes for aesthetic restorative types.15 Chin and Tayas reported increase in bond strength at time at time of acid application is delayed from 5 to 15 minutes.16 But Hinoura reported non-significant differences in bond strength if time of application is delayed.6 In this study etching of Glass Ionomer cement was done 7 minutes after mixing was started which was the maturation time of cement given by manufacturer.

Both the Glass Ionomer cement and the composite resin have been used in bulk in this study, to judge the proper tensile bond strength which is often erroneous if used in thin film, though clinically 6mm thickness is almost impossible to achieve other than in Class II composite restoration. The incrementally placed composite is also helpful to judge the effect of polymerization contraction of composite (as may happen clinically) on the bond strength to Glass Ionomer cement. Two different composite resins, microfilled and hybrid did not show any appreciable difference in bond strength to etched and unetched Glass Ionomer cement. It was in accordance to results reported by Hinoura.14 It probably indicated filler content and size probably do not affect bond strength. 37% Phosphoric acid is the optimum concentration being used universally. There has been no difference found in bond strength if concentration is increased from 37% to 50%. Nowadays studies involving lesser concentration of acids are increasing in number but they are not yet clinically recommended.

Importance of bonding agent was emphasized by Causton17 who reported greatly increased bond strength between these two materials. Hinoura has stressed upon importance of wet ability, viscosity and contact angle formed by bonding agent.
It has also been shown that following acid etching, deep penetration of bonding agent and composite resin in to partially destroyed Glass Ionomer surface form a resin reinforced Glass Ionomer complex.\(^1,18\) But during tensile load/bond strength tests, fracture mainly occurs internal to this area. In this study, failure occurred both adhesively and cohesively within the glass-ionomer, both in etched and unetched specimens during tensile stress loading. This finding also did not correlate with previous studies most of which reported predominantly adhesive failure with unetched Glass Ionomer composite couple and cohesive failure with etched Glass Ionomer–composite couple, mainly within Glass Ionomer components. It also stresses the importance of increasing tensile bond strength of Glass Ionomer to dentin while keeping the bond strength between Glass Ionomer – composite static.

The combination of Glass Ionomer – composite resin must have certain strength to withstand a variety of stresses developing in cavity both during curing of composite resin and during lateral and mechanical loading. The type and magnitude of this stress is dependent of type, size and geometry of cavity, type and volume of composite resin, time after insertion, varying thermal and mechanical loads etc. It is difficult to develop an in vitro method to cover all these variables. So the present test is therefore only capable of ranking strength of such systems at a certain time after start of mixing under predominantly tensile stress situation. The time chosen in present study was 24 hours after application of materials. This time was found to be relevant in considering possibilities of reducing or eliminating stresses during curing of composite resin in many cavities and ii) the conventional Glass Ionomer cement will increase considerably in strength in first 24 hours of setting followed by a significant increase in bond strength. Clinically studies evaluating Sandwich techniques are till date very few and far between. Welbury in a 2 year clinical study reported significant failure in Glass Ionomer component when it is extended to cavo- surface margin(open sandwich), thereby advising against open method.\(^11\)

**Conclusion**

The results showed no significant differences between any of four groups, showing that application of 37% phosphoric acid did not result in significant bond strength between Glass Ionomer cement and composite resin. Both the types of composite resin also did not show any significant difference in bond strength to Glass Ionomer cement, whether etched or unetched. Further laboratory and clinical evaluation of this technique is necessary before clinical recommendations.

**Authors Affiliations**


### References


How to cite this article

Address for Correspondence
Dr. Aditya Mitra MDS,
Professor, Dept. of Endodontics,
Horizon Dental College and Research Institute,
Sakri, Bilaspur, Chhattishgarh, India.
Email: adityamitra@gmail.com

Source of Support: Nil
Conflict of Interest: None Declared